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POLICY BRIEF - 78

Impact Evaluation of the Pilot Project: Development of Model Villages under the Soil Health Card Scheme

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Background

Soil is a vital natural resource whose physical, chemical, and biological properties sustain agricultural productivity and ecological balance. Globally, growing concerns over soil degradation have led to international recognition through initiatives such as the International Year of Soils (2015) and World Soil Day (December 5). In India, agriculture remains deeply rooted in diverse soils across 15 agro-climatic zones, with over 54.6 per cent of the workforce dependent on agriculture and allied activities (Census, 2011).

Soil health, defined as the soil's capacity to function as a living system that supports plant, animal, and human life, is critical for sustainable agriculture. The balanced availability of macronutrients, secondary nutrients, and micronutrients is essential for crop growth; however Indian agriculture continues to exhibit skewed nutrient use due to distorted subsidy structures, particularly favoring urea. This has resulted in significant regional imbalances, soil degradation, environmental externalities, and increased dependence on fertilizer imports.

To address these challenges, the Government of India launched the Soil Health Card (SHC) Scheme in February 2015, with the objective of promoting soil test-based and balanced fertilizer use. The scheme provides farmers with crop-specific nutrient recommendations based on scientific soil testing of 12 key soil parameters. Over 22 crore SHCs were distributed nationwide during Cycles I and II. Building on this, the Model Village Programme (MVP) was introduced in 2019-20 under the third cycle, shifting from grid-based sampling to individual landholding-based soil assessment and intensive village-level demonstrations to improve adoption.

Despite the demonstrated benefits, such as reduced cost of cultivation, improved yields, and better nutrient management, studies have revealed limitations related to farmers' understanding of SHC recommendations, delayed distribution, and weak extension support. In this context, evaluating the MVP provides a critical opportunity to assess whether village-centric participatory soil testing improves adoption, fertilizer use efficiency, and farm outcomes. Therefore, this study examines the impact of the MVP-SHC initiative to generate evidence-based insights for strengthening soil health management and advancing sustainable agriculture in India.

Methodology

The study is based on both primary and secondary data and follows an ex-post facto research design, as the Model Village Programme (MVP) under the Soil Health Card (SHC) Scheme had already been implemented and the researchers had no control over treatment variables.

Study Area and Coverage

Six states- Andhra Pradesh, Tamil Nadu, Maharashtra, Madhya Pradesh, Uttar Pradesh, and Karnataka-were purposively selected based on the highest number of SHCs issued during Cycles I and II and the first year of the MVP (2019-20), while ensuring representation of five agro-climatic zones. The study was implemented through six Agro-Economic Research Centres (AERCs), with the ADRTC, ISEC, Bengaluru, preparing the consolidated report.

Sampling Framework

A multistage random sampling technique was adopted with a total sample size of 2,160 farmers (360 per state). In each state, three districts were selected based on agro-climatic diversity and MVP-SHC coverage areas. From each district, four taluks were chosen, and one model village per taluk was selected, resulting in 12 model villages per district. Thirty farmers were randomly selected from each village. One SHC per farmer was considered irrespective of fragmented landholdings, as the study focused on farmer awareness, adoption, and perceptions, rather than plot-level SHCs.

Data Collection

Primary data were collected through structured household surveys, supplemented by focus group discussions (FGDs) and key informant interviews with officials from the State Agriculture Departments, District Agriculture Offices, KVKs, and RSKs. Secondary data were sourced from the SHC portal, IndiaStat, and official records.

Analytical Methods

Quantitative analysis included the following:

- **Cost and return analysis** using standard budgeting techniques,
- **Cobb-Douglas production function** to assess resource use efficiency,
- **Data Envelopment Analysis (DEA)** to estimate technical, allocative, and economic efficiencies under constant and variable returns to scale.

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Qualitative analysis assessed the farmers' knowledge and adoption levels of the SHC recommendations. Knowledge scores were derived from responses to 16 SHC-related questions and classified into low, medium, and high categories using the mean and standard deviation. Adoption was measured based on the use of the recommended macro- and micronutrients. Additionally, Garrett's Ranking Technique was employed to prioritize farmers' motivations, constraints, and perceptions regarding SHC adoption.

Result and Discussion

Socio-economic profile of beneficiary farmers

Table 1 presents the socioeconomic status of the beneficiaries in the study area. Across the six states, MVP-SHC beneficiaries are predominantly middle-aged farmers (56.62%), followed by senior farmers (32.41%), with a relatively low participation of young farmers (10.97%). Educational attainment was moderate, with primary education (29.07%) and secondary/higher secondary education (36.67%) forming the majority. Illiteracy accounts for 23.70 percent, indicating the need for simple and localized SHC advisories.

The average operational landholding is 4.99 acres, with notable inter-state variation, being the highest in Madhya Pradesh and Uttar Pradesh. Agriculture is the primary occupation of 68.98 percent of the respondents, underlining the relevance of SHC recommendations for livelihood security. Housing conditions show moderate asset ownership, as 86.11 percent of farmers live in semi-pucca or pucca houses.

The average annual family income across all states is ₹2,11,092, with Maharashtra recording the highest income and Andhra Pradesh the lowest, highlighting the uneven economic outcomes among MVP-SHC beneficiaries.

Table 1: Socio-economic indicators of MVP-SHC beneficiaries

Indicator	Value
Young farmers (18-35 years)	10.97 %
Middle-aged farmers (36-59 years)	56.62 %
Illiterate farmers	23.70 %
Primary + Secondary education	65.74 %
Average landholding	4.99 acres
Primary occupation (agriculture)	68.98 %
Average annual family income	₹2,11,092

Source: Primary data, Authors' Calculation

Impact of SHC usage on cropping pattern

The adoption of Soil Health Cards under MVP has resulted in a net expansion of the cultivated area across seasons, as shown in **Table 2.** The total cropped area increased from 8,845.28 acres before SHC usage to 9,338.78 acres after SHC usage, indicating improved land intensity.

The most significant gains were observed during the Kharif season, followed by the Rabi and Summer seasons, particularly in Karnataka, Maharashtra, and Madhya Pradesh. Andhra Pradesh shows negligible change, while Tamil Nadu records only marginal improvement.

Table 2: Change in cropped area before and after SHC usage (Overall)

Season	Before SHC (acres)	After SHC (acres)	Change (acres)
Kharif	4,694.53	5,016.33	+321.80
Rabi	3,179.94	3,254.49	+74.55
Summer	240.19	323.86	+83.67
Perennial	730.63	744.10	+13.47
Overall	**8,845.28**	**9,338.78**	**+493.50**

Source: Primary data, Authors' Calculation

Impact on Resource Use Efficiency of Major Crops in the Study Region

Resource use efficiency was analysed using the ratio of Marginal Value Product (MVP) to

Marginal Factor Cost (MFC), where $r = MVP/MFC$.

An r value of equal to 1 indicates optimal input use, $r > 1$ indicates underutilization, and $r < 1$ indicates overutilization.

Before the implementation of the MVP-SHC, most crops exhibited suboptimal use of key inputs, particularly human labor, seeds, fertilizers, manure, and plant protection chemicals (PPC). After MVP-SHC, the r values for several inputs moved closer to unity, indicating improved resource-use efficiency across crops (**Table 3**).

Table 3: Direction of change in resource use efficiency after MVP-SHC

Crop	Inputs showing improvement	Inputs remaining sub-optimal
Soyabean	Human labour, Seed, Manure	PPC
Maize	Human labour, Machine labour, Seed	PPC
Areca-nut	Human labour, Machine labour, Manure	Fertilizer, PPC
Paddy	Machine labour, Seed	PPC
Wheat	Human labour, Machine labour, PPC	Fertilizer
Mustard	Human labour, PPC	Machine labour, Fertilizer

Source: Primary data, Authors' Calculation

In soybeans, efficiency improved notably for human labor, seed, and manure after MVP-SHC, while PPC continued to remain suboptimal. In maize, efficiency gains were observed in human labor, machine labor, and seed, although PPC remained inefficient. For areca-nut, improvements were recorded in human labor, machine labor, and manure, but fertilizer and PPC use remained suboptimal. In paddy, machine labor and seed efficiency improved after MVP-SHC, whereas PPC continued to show inefficiency. In wheat, human labor, machine labor, and PPC efficiency improved after MVP-SHC, although fertilizer use remained inefficient. In mustard, human labor and PPC efficiency improved, whereas machine labor and fertilizer remained suboptimal.

Difference between Recommended and Actual Application of Macro Nutrients

Table 4 reveals substantial gaps between the recommended and actual application of macronutrients (N, P, K) across states and crops. In Karnataka, farmers applied significantly lower quantities of nitrogen, phosphorus, and potassium than recommended for soybean, maize, and areca-nut, indicating widespread under-application of nutrients. A similar under-application of nitrogen and potassium was observed in Andhra Pradesh, particularly for paddy crops, although phosphorus application varied across crops.

Table 4: General pattern of macro nutrient application

State	Major observation
Karnataka	Severe under-application of N, P, K
Andhra Pradesh	Under-application of N and K; variable P
Tamil Nadu	Near-optimal application
Maharashtra	Slight under-application
Madhya Pradesh	Excess N; deficit P and K
Uttar Pradesh	Mixed under- and over-application

Source: Primary data, Authors' Calculation

In Tamil Nadu and Maharashtra, the deviations between the recommended and actual nutrient application were relatively small, suggesting closer adherence to the Soil Health Card (SHC) recommendations. In contrast, Madhya Pradesh showed excessive application of nitrogen for paddy and mustard, whereas phosphorus and potassium were under-applied for wheat and mustard, indicating imbalanced fertilizer use. Uttar Pradesh exhibited mixed patterns, with under-application of nutrients in Crop 1 and Crop 3 paddy, and over-application in Crop 2 paddy.

Adoption Level of Macro-Nutrient Recommendations

Table 5 indicates a clear improvement in the adoption of macro-nutrient recommendations after MVP implementation. At the overall level, the proportion of farmers with high adoption increased from 25.6% to 33.1%, whereas low adoption declined from 47.69% to 41.16%.

The most notable improvement was observed in Madhya Pradesh, where high adoption increased by 16.67 percentage points. Maharashtra and Uttar Pradesh also showed substantial shifts from the low to the high adoption categories. Karnataka recorded a modest but positive improvement, while Andhra Pradesh and Tamil Nadu showed moderate gains.

These results suggest that the MVP-SHC program has been effective in improving farmers' adherence to recommended macronutrient practices, although low adoption levels remain significant.

Table 5: Change in adoption level of macro nutrients (Overall)

Adoption level	Before (%)	After (%)	Change (%)
Low	47.69	41.16	-6.53
Medium	26.71	25.74	-0.97
High	25.60	33.10	+7.50

Source: Primary data, Authors' Calculation

Application of Micro and Organic Nutrients

Table 6 shows that MVP-SHC had a positive impact on the adoption of micro and organic nutrients, although the magnitude varied widely across states and crops. Karnataka recorded substantial increases in sulphur, zinc, boron, and organic manure application, particularly for soybean, maize, and areca-nut. Andhra Pradesh showed improved use of sulphur, zinc, boron, and iron in paddy, though organic manure use remained largely unchanged.

In Tamil Nadu, the application of micro-nutrients remained negligible, with only marginal increases in organic manure. Maharashtra witnessed notable increases in sulfur and zinc for soybean and paddy, while Madhya Pradesh showed mixed results, including reductions in certain micronutrients for paddy and mustard. Uttar Pradesh exhibited no use of micro-nutrients, although organic manure application increased modestly for all paddy crops.

Overall, the MVP-SHC program encouraged a shift towards organic manure and selective micro-nutrient use, but adoption remains uneven across states.

Table 6: Trend in micro/organic nutrient use after MVP-SHC

State	Major change observed
Karnataka	Strong increase in micro-nutrients and organic manure
Andhra Pradesh	Increased sulphur, zinc, boron in paddy
Tamil Nadu	Marginal increase in organic manure only
Maharashtra	Increased sulphur and zinc
Madhya Pradesh	Mixed response; some reductions
Uttar Pradesh	Increase only in organic manure

Source: Primary data, Authors' Calculation

Extent of Farmers' Awareness of the Soil Health Card Scheme Farmers' Awareness of Various Facets of MVP-SHC

Table 7 highlights substantial inter-state variation in farmers' awareness of the Model Village Programme-Soil Health Card (MVP-SHC). Overall, 74.21 percent of farmers were aware of MVP, with the highest awareness in Uttar Pradesh (99.17%) and the lowest in Karnataka (55%). Awareness of the soil sampling procedure was relatively high (72.31%), whereas awareness of soil-testing laboratories was moderate (51.85%).

Awareness of digital platforms, particularly the SHC website, was extremely low at 15.32 percent. Knowledge of soil health parameters such as pH, organic carbon, and EC remained limited, while awareness of primary nutrients (N, P, and K) exceeded 73 percent at the aggregate level. Awareness of secondary and micronutrients was generally low and uneven across states, with Karnataka consistently recording the lowest awareness levels. Participation in demonstrations and farmer-to-farmer dissemination was limited, indicating weak horizontal knowledge diffusion in the region.

Table 7: Farmers' Awareness of Key MVP-SHC Components (Overall)

Aspect	Awareness (%)
Knowledge of MVP	74.21
Procedure of soil sampling	72.31
Awareness of soil testing lab	51.85
Awareness of SHC website	15.32
Awareness of pH	40.56
Awareness of organic carbon	49.49
Awareness of EC	46.81
Awareness of Nitrogen (N)	76.34
Awareness of Phosphorus (P)	73.56
Awareness of Potassium (K)	73.47
Demo farmer (self)	21.67
Fellow farmers informed	9.17
SHC received before sowing	74.72

Source: Primary data, Authors' Calculation

Extent of Knowledge of MVP-SHC Scheme and SHC Contents

Table 8 shows that farmers' knowledge of MVP-SHC and SHC content is evenly distributed across the low, medium, and high categories at the aggregate level. Approximately 32.55 percent of farmers fell under the high-knowledge category, while 33.52 percent exhibited low knowledge. Tamil Nadu and Maharashtra recorded relatively higher proportions of farmers with high knowledge, whereas Karnataka and Madhya Pradesh require greater capacity-building efforts.

Table 8: Extent of Knowledge of MVP-SHC Scheme and SHC Contents (Overall)

Knowledge Level	Farmers (%)
Low	33.52
Medium	33.94
High	32.55

Source: Primary data, Authors' Calculation

Factors Motivating Farmers to Adopt SHC Recommendations

Table 9 presents the factors motivating farmers to adopt SHC recommendations in the three states. At the overall level, an increase in productivity emerged as the most influential factor, followed by the control of soil-borne diseases and the improvement of crop growth. The reduction in pest incidence and improvement in produce quality ranked relatively lower, indicating that farmers prioritize immediate yield and cost benefits over long-term quality considerations.

Table 9: Overall Ranking of Factors Motivating SHC Adoption

Motivating Factor	Overall Rank
Helps increase productivity	I
Helps control soil-borne diseases	II
Improves crop growth	III
Increases germination percentage	IV
Helps reduce fertilizer application	V
Helps overcome soil salinity problems	VI
Helps increase quality of produce	VII
Reduces incidence of pests	VIII

Source: Primary data, Authors' Calculation

Constraints Faced by Farmers in Adoption of SHC Recommendations

Table 10 presents the major constraints faced by farmers in adopting Soil Health Card (SHC) recommendations across the study states. The severity of the constraints varies considerably across regions, reflecting differences in institutional access, awareness levels, and input availability.

At the overall level, the most severe constraint was the non-availability of the recommended quantity of nutrients (Rank I), followed by soil testing laboratories being far away (Rank II) and difficulty in understanding the information provided on SHCs (Rank III). Other important constraints include a lack of knowledge of soil sampling procedures, a lack of trust in SHC information, and delays in the distribution of SHCs. Financial constraints and a lack of awareness, though present, are relatively less severe at the aggregate level.

Overall, the findings suggest that supply-side bottlenecks (nutrient availability and lab access) and information-related barriers (comprehension and trust) are the primary factors limiting the effective adoption of SHC recommendations.

Table 10: Major Constraints in Adoption of SHC Recommendations

Constraint	Overall Rank
Non-availability of recommended quantity of nutrients	I
Soil testing laboratories are far away	II
Difficult to understand information given on SHC	III
No knowledge of soil sampling procedure	IV
Lack of trust in SHC information (reliability)	V
Insufficient credit/funds to follow SHC recommendations	VI
Delay in SHC distribution	VII
Lack of interest in obtaining SHC	VIII
Did not notice changes in SHC adopter's field	IX
Satisfaction with traditional practices	X
Unaware of benefits of SHC	XI

Source: Primary data, Authors' Calculation

Policy Suggestions

The study's findings indicate that the Model Village Programme--Soil Health Card (MVP--SHC) has positively influenced cropping patterns, nutrient use efficiency, and farmers' productivity. Based on the empirical evidence, the following policy suggestions are proposed:

1. **Promotion and Scaling-up of SHC Adoption:** The use of Soil Health Cards has contributed to the expansion of cultivated areas and improved nutrient management. The Government should intensify efforts to promote SHC adoption through awareness campaigns, input subsidies, and incentive mechanisms, particularly in low-adoption regions.
2. **Enhancing Awareness and Communication:** Since the overall awareness of MVP-SHC is moderate, targeted communication strategies using radio, television, mobile messaging, and social media should be adopted to disseminate information on SHC benefits and usage.
3. **Timely Distribution of SHCs:** Delays in SHC distribution significantly reduce their adoption. A fixed operational calendar should be followed: soil sampling in March, SHC distribution in April, and training programs in May, before the onset of the monsoon season.
4. **Capacity Building at the Village Level:** Continuous and frequent village-level training programs are required to improve farmers' understanding of SHC technology, recommended doses of fertilizers, and sustainable agricultural practices.
5. **Simplification of Fertilizer Recommendations:** Fertilizer recommendations should be provided in **local land measurement units,** such as gunta, bigha, or acre, instead of per hectare, to improve comprehension and practical adoption.
6. **Digital Alerts for SHC Availability:** Once soil analysis data are uploaded, farmers should receive SMS or WhatsApp alerts to enable the timely download or collection of SHCs.
7. **Linking SHCs with Fertilizer Sales:** Fertilizer retailers should insist on SHCs while selling fertilizers, ensuring recommendation-based fertilizer use and reducing diversion.
8. **Convergence with Other Departments:** Departments such as Horticulture, Sericulture, and Commodity Boards should mandate SHC compliance while providing benefits, thereby reinforcing the importance of SHCs.
9. **Multi-stakeholder Engagement:** Regular interaction among farmers, scientists, extension personnel, and policymakers should be institutionalized to develop a **co-innovation roadmap** for wider SHC adoption.
10. **Public-Private Collaboration:** Given farmers' greater trust in private advisory services, joint efforts between State Agricultural Universities and private companies should be encouraged to develop reliable, farmer-centric nutrient recommendations while safeguarding farmers' interests.

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